Various applications of Graph Theory

Y.Lavanya[1], Ch.Achireddy[2],N.Amarnath[3]
[1]Assistant professor, Department Mathematics Marri Laxman Reddy Institute of Technology and Sciences, Hyderabad
[2]Associate professor(PHD), Department Mathematics Marri Laxman Reddy Institute of Technology and Sciences, Hyderabad
[3]Assistant professor, Department Mathematics Marri Laxman Reddy Institute of Technology and Sciences, Hyderabad

ABSTRACT: Graphs are among the most ubiquitous models of both natural and human-made structures. They can be used to model many types of relations and process dynamics in computer science, physical, biological and social systems. Many problems of practical interest can be represented by graphs. In general graphs theory has a wide range of applications in diverse fields. This paper explores different elements involved in graph theory including graph representations using computer systems and graph-theoretic data structures such as list structure and matrix structure. The emphasis of this paper is on graph applications in computer science. To demonstrate the importance of graph theory in computer science, this article addresses most common applications for graph theory in computer science. These applications are presented especially to project the idea of graph theory and to demonstrate its importance in computer science.

Key words: Vertices, Edges, Graph coloring.

I.INTRODUCTION

In mathematics and computer science, **graph theory** is the study of graphs, which are mathematical structures used to model pairwise relations between objects. A "graph" in this context is made up of "vertices" or "nodes" and lines called edges that connect them. A graph may be undirected, meaning that there is no distinction between the two vertices associated with each edge, or its edges may be directed from one vertex to another; see graph (mathematics) for more detailed definitions and for other variations in the types of graph that are commonly considered. Graphs are one of the prime objects of study in discrete mathematics. This paper having two parts part-A having history of graph, part-B having applications of graph theory

Part-A:

History of Graph theory:

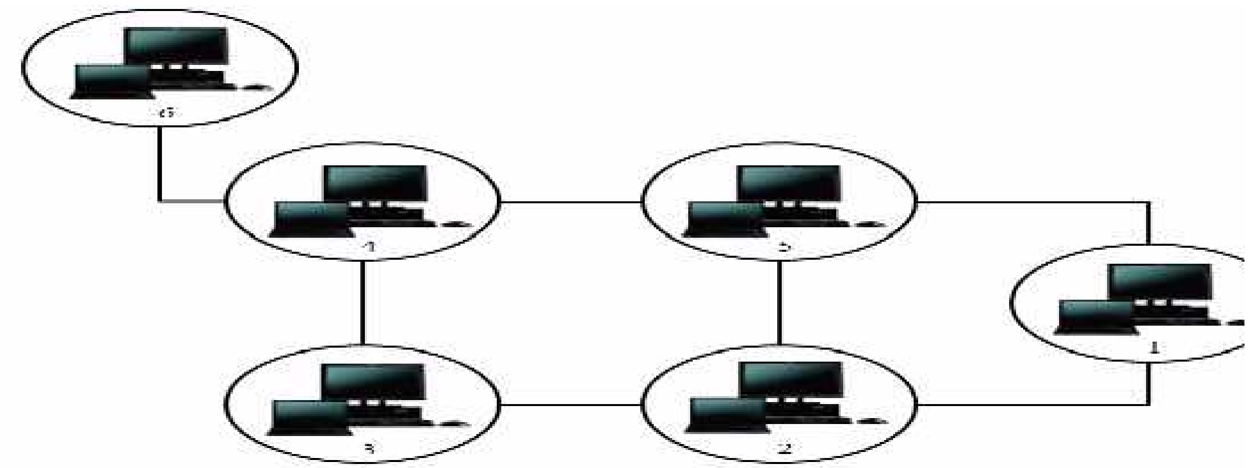
The paper written by Leonhard Euler on the Seven Bridges of Königsberg and published in 1736 is regarded as the first paper in the history of graph theory. This paper, as well as the one written by Vandermonde on the knight problem, carried on with the analysis situs initiated by Leibniz. Euler's formula relating the number of edges, vertices, and faces of a convex polyhedron was studied and generalized by Cauchy and L'Huillier, and is at the origin of topology.

More than one century after Euler's paper on the bridges of Königsberg and while Listing introduced topology, Cayley was led by the study of particular analytical forms arising from differential calculus to study a particular class of graphs, the trees. This study had many implications in theoretical chemistry. The involved techniques mainly concerned the enumeration of graphs having particular properties. Enumerative graph theory then rose from the results of Cayley and the fundamental results published by Pólya between 1935 and 1937 and the generalization of these by De Bruijn in 1959. Cayley linked his results on trees with the contemporary studies of chemical composition. The fusion of the ideas coming from mathematics with those coming from chemistry is at the origin of a part of the standard terminology of graph theory.

Applications of Graph theory:

1. Computer Network Security

A team of computer scientists led by Eric Filiol at the Virology and Cryptology Lab, ESAT, and the French Navy, ESCANSIC, have recently used the vertex cover algorithm to simulate the propagation of stealth worms on large computer networks and design optimal strategies for protecting the network.



The simulation was carried out on a large internet-like virtual network and showed that that the combinatorial topology of routing may have a huge impact on the worm propagation and thus some servers play a more essential and significant role than others. The real-time capability to identify them is essential to greatly hinder worm propagation. The idea is to find a minimum vertex cover in the graph whose vertices are the routing servers and whose edges are the (possibly dynamic) connections between routing servers. This is an optimal solution for worm propagation and an optimal solution for designing the network defense strategy. Figure 5.1 above shows a simple computer network and a corresponding minimum vertex cover {2, 4, 5}.

2. Map Coloring and GSM Mobile Phone Networks

Given a map drawn on the plane or the surface of a sphere, the famous four color theorem asserts that it is always possible to properly color the regions of the map such that no two adjacent regions are assigned the same color, using at most four distinct colors. For any given map, we can construct its dual graph as follows. Put a vertex inside each region of the map and connect two distinct vertices by an edge if and only if their respective regions share a whole segment of their boundaries in common.

3. Graph theory and its applications in wireless networks:

Wireless multi-hop networks, in various forms, e.g. wireless sensor networks, underwater sensor networks, vehicular networks, mesh networks and UAV (Unmanned Aerial Vehicle) formations, and under various names, e.g. ad-hoc networks, hybrid networks, delay tolerant networks and intermittently connected networks, are being increasingly used in military and civilian applications. Graph theory, particularly a recently developed branch of graph theory, i.e. random geometric graphs, is well suited to studying these problems. These include but not limited to: cooperative communications; opportunistic routing; geographic routing; statistical characterization (e.g. connectivity, capacity and delay) of multi-hop wireless networks; geometric constraints among connected nodes and their use in autonomous parameter estimation without manual calibration. This research will investigate the use of graph theory to solve problems in the above broad areas. Research outcomes will benefit almost all areas in wireless multi-hop networks, including routing, scheduling, mobility management, dimensioning, interference control, energy management and localization.

4.Data base designing

In data base designing graphs are used as graph data bases . Graph database uses graph representation with nodes, edges, and properties to represent and store data. This graph structurehas key role in designing database, because it gives fast implementation process using different functionality and properties of graph structure .Graph database uses as:

- Storage system that provides index free adjacency
- Analyzing tool for interconnection
- Powerful tool for graph like-query
- Graph databases are often faster for associative data

5. Data mining

Graph mining is the main application area of graph theory in data mining. Graph mining represents the relational aspect of data. There are five theoretical based approaches of graph based data mining. They are sub graph categories, sub graph isomorphism, graph invariants, mining measures and solution methods.

6.Operating system:

A graph is a data structure of finite set of pairs, called edges or vertices. Many practical problems can be solved with the help of graph in the field of operating system such as job scheduling and resource allocation problems. For example graph coloring concept can be applied in job scheduling problems of CPU, jobs are assumed as vertices of the graph and there will be an edge between two jobs that cannot be executed simultaneously and there will be one to one relationship between feasible scheduling of graphs .

7.Graph theory in Chemistry:

Graphs are used in the field of chemistry to model chemical compounds. In computational biochemistry some sequences of cell samples have to be excluded to resolve the conflicts between two sequences. This is modeled in the form of graph where the vertices represent the sequences in the sample. An edge will be drawn between two vertices if and only if there is a conflict between the corresponding sequences. The aim is to remove possible vertices, (sequences) to eliminate all conflicts. In brief, graph theory has its unique impact in various fields and is growing large now a days. The subsequent section analyses the applications of graph theory especially in computer science.

CONCLUSION

The main aim of this paper is to present the importance of graph theoretical ideas in various areas of compute applications for researches that they can use graph theoretical concepts for the research. An overview is presented especially to project the idea of graph theory. So, the graph theory section of each paper is given importance than to the other sections. Researches may get some information related to graph theory and its applications in computer field and can get some ideas related to their field of research.

Reference:

[1] K.Appel and W.Haken,Every planar map is Four colorable,Bull.Amer.Math.Soc(1976) 711-712

[2] L.Babai,some applications of graph contractions,J.Graph Theory,vol.l(1977) 125-130

[3] E.Bertram and P.Horak, some application of graph theory to other parts of mathematics,The Mathematical Intelligencer(Spromger-verlag,New York)(1999)6-11

[4] J. A. Bondy and U.S.R. Murty.Graph Theory with Applications,1976,Elsevier Science Publishing Company Inc.

[5] L.Caccetta and k.Vijayan,Application of graph theory,fourteenth Australasian Conference on Combinatorial Mathematics and Computing(Dunedin,1986)

[6] Ashay Dharwadker,The verter cover Algorithm2006.

[7] Ashay Dharwadker,A verter coloring Algorithm2006.